

WHAT IS CLAIMED IS:

1. A display apparatus comprising:

- (a) a light source for forming a beam of light;
- (b) a pre-polarizer for polarizing said beam of light to provide a polarized beam of light;
- (c) a wire grid polarizing beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;
- (d) a reflective liquid crystal device for selectively modulating said polarized beam of light having a second polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;
- (e) a compensator, located between said wire grid polarization beamsplitter and said reflective liquid crystal device, for conditioning oblique and skew rays of said modulated beam;
- (f) wherein said wire grid polarizing beamsplitter reflects said compensated modulated beam;
- (g) a polarization analyzer which removes residual unmodulated first polarization light; and
- (h) image-forming optics for forming an image from said modulated beam.

2. The apparatus of claim 1 wherein said compensator comprises one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

3. The A-plate according to claim 2 wherein the optical axis of said A-plate is substantially parallel to the sub-wavelength wires of said wire grid polarization beamsplitter.

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4. The A-plate according to claim 2 wherein the optical axis of said A-plate is substantially perpendicular to the sub-wavelength wires of said wire grid polarization beamsplitter.

5. The apparatus of claim 1 wherein said reflective liquid crystal device has a vertically aligned construction.

6. The compensator of claim 1 which modifies polarization states of the oblique and skew rays relative to said wire grid polarization beamsplitter, or said reflective liquid crystal device, or both.

7. A modulation optical system for providing high contrast modulation of an incident light beam, comprising:

(a) a pre-polarizer for pre-polarizing said beam of light to provide a polarized beam of light;

(b) a wire grid polarization beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;

(c) a reflective liquid crystal device for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;

(d) a compensator, located between said wire grid polarization beamsplitter and said reflective liquid crystal device, for conditioning oblique and skew rays of said modulated beam;

(e) a polarization analyzer which removes residual unmodulated first polarization light.

8. The system of claim 7 wherein said compensator comprises one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

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9. The A-plate according to claim 8 wherein the optical axis of said A-plate is substantially parallel to the sub-wavelength wires of said wire grid polarization beamsplitter.

10. The A-plate according to claim 8 wherein the optical axis of said A-plate is substantially perpendicular to the sub-wavelength wires of said wire grid polarization beamsplitter.

11. The system of claim 7 wherein said reflective liquid crystal device has a vertically aligned construction.

12. The compensator of claim 7 which modifies polarization states of the oblique and skew rays relative to said wire grid polarization beamsplitter, or said reflective liquid crystal device, or both.

13. A modulation optical system for providing high contrast modulation of an incident light beam, comprising:

(a) a wire grid pre-polarizer for pre-polarizing said beam of light;

(b) a wire grid polarization beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;

(c) a reflective liquid crystal device for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;

(d) a compensator, located between said wire grid polarization beamsplitter and said reflective liquid crystal device, for conditioning oblique and skew rays of said modulated beam; and

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(e) a wire grid polarization analyzer which removes residual unmodulated first polarization light.

14. The system of claim 13 wherein said compensator comprises one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

15. The A-plate according to claim 14 wherein the optical axis of said A-plate is substantially parallel to the sub-wavelength wires of said wire grid polarization beamsplitter.

16. The A-plate according to claim 14 wherein the optical axis of said A-plate is substantially perpendicular to the sub-wavelength wires of said wire grid polarization beamsplitter.

17. The system of claim 13 wherein said reflective liquid crystal device has a vertically aligned construction.

18. The compensator of claim 13 which modifies polarization states of the oblique and skew rays relative to said wire grid polarization beamsplitter, or said reflective liquid crystal device, or both.

19. A modulation optical system for providing high contrast modulation of an incident light beam, comprising:

(a) a wire grid pre-polarizer for pre-polarizing said beam of light;

(b) a wire grid polarization beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;

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(c) a reflective liquid crystal device for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;

(d) a wire grid polarization analyzer which removes unmodulated first polarization light; and

(e) a compensator which conditions oblique and skew rays relative to said wire-grid polarization analyzer and said wire grid pre-polarizer.

20. The system of claim 19 wherein said compensator comprises one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

21. The A-plate according to claim 20 wherein the optical axis of said A-plate is substantially parallel to the sub-wavelength wires of said wire grid polarization analyzer.

22. The A-plate according to claim 20 wherein the optical axis of said A-plate is substantially perpendicular to the sub-wavelength wires of said wire grid polarization analyzer.

23. The system of claim 19 wherein said reflective liquid crystal device has a vertically aligned construction.

24. The system of claim 19 wherein said compensator is located between said wire grid pre-polarizer and said wire grid polarization beamsplitter.

25. The system of claim 19 wherein said compensator is located between said wire grid polarization beamsplitter and said wire grid polarization analyzer.

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26. A modulation optical system for providing high contrast modulation of an incident light beam, comprising:

(a) a wire grid pre-polarizer for pre-polarizing said beam of light;

(b) a transmissive liquid crystal device for selectively modulating said polarized beam of light having to encode image data thereon in order to form a modulated beam;

(c) a wire grid polarization analyzer which transmits said modulated beam and blocks and unmodulated beam; and

(d) a compensator located between said transmissive liquid crystal device and said wire grid polarization analyzer which conditions oblique and skew rays.

27. The system of claim 26 wherein said compensator comprises one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

28. The A-plate according to claim 27 wherein the optical axis of said A-plate is substantially parallel to the sub-wavelength wires of said wire grid polarization analyzer.

29. The A-plate according to claim 27 wherein the optical axis of said A-plate is substantially perpendicular to the sub-wavelength wires of said wire grid polarization analyzer.

30. The system of claim 26 wherein said reflective liquid crystal device has a vertically aligned construction.

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31. The apparatus of claim 26 wherein the polarization axis orientation of said wire grid pre-polarizer is perpendicular to the polarization axis orientation of said wire grid polarization analyzer.

32. The apparatus of claim 26 wherein the polarization axis orientation of said wire grid pre-polarizer is parallel to the polarization axis orientation of said wire grid polarization analyzer.

33. A display apparatus comprising:

- (a) a light source for forming a beam of light;
- (b) a wire grid pre-polarizer for polarizing said beam of light to provide a polarized beam of light;
- (c) a wire grid polarizing beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;
- (d) a reflective liquid crystal device for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;
- (e) a compensator, located between said wire grid polarization beamsplitter and said reflective liquid crystal device, for conditioning oblique and skew rays of said modulated beam;
- (f) a wire grid polarization analyzer which removes residual unmodulated first polarization light; and
- (g) image-forming optics for forming an image from said modulated beam.

34. The system of claim 33 wherein said compensator comprises one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

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35. The A-plate according to claim 34 wherein the optical axis of said A-plate is substantially parallel to the sub-wavelength wires of said wire grid polarization beamsplitter.

36. The A-plate according to claim 34 wherein the optical axis of said A-plate is substantially perpendicular to the sub-wavelength wires of said wire grid polarization beamsplitter.

37. The system of claim 33 wherein said reflective liquid crystal device has a vertically aligned construction.

38. The compensator of claim 33 which modifies polarization states of the oblique and skew rays relative to said wire grid polarization beamsplitter, or said reflective liquid crystal device, or both.

39. A display apparatus comprising:

- (a) a light source for forming a beam of light;
- (b) a wire grid pre-polarizer for polarizing said beam of light to provide a polarized beam of light;
- (c) a wire grid polarizing beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;
- (d) a reflective liquid crystal device for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;
- (e) a first compensator located between said wire grid polarization beamsplitter and said reflective liquid crystal device, for conditioning oblique and skew rays of said modulated beam;

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(f) a wire grid polarization analyzer which removes residual unmodulated first polarization light;

(g) a second compensator for conditioning oblique and skew rays of said wire grid polarizing beamsplitter relative to said wire grid polarization analyzer and said wire grid pre-polarizer; and

(h) image-forming optics for forming an image from said modulated beam.

40. The system of claim 39 wherein said first compensator and said second compensator each comprise one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

41. The system of claim 39 wherein said reflective liquid crystal device has a vertically aligned construction.

42. The first compensator of claim 39 which modifies polarization states of the oblique and skew rays relative to said wire grid polarization beamsplitter, or said reflective liquid crystal device, or both.

43. A method for projecting an image generated from image data, the method comprising:

(a) providing a polarized light beam;

(b) directing said polarized light beam to a wire grid polarizing beamsplitter, said beamsplitter transmitting incident light having a first polarization as a transmitted beam, and reflecting incident light having a second polarization as a reflected beam;

(c) modulating said transmitted beam from said wire grid polarizing beamsplitter to encode image data at a reflective liquid crystal device and to provide a modulated beam;

(d) disposing a compensator in the path of said modulated beam to remove leakage light from said modulated beam; and

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(e) projecting said modulated beam to form said image.

44. A display apparatus comprising:

(a) a light source for forming a beam of light;

(b) a wire grid pre-polarizer for polarizing said beam of light to provide a polarized beam of light;

(c) a wire grid polarizing beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;

(d) a reflective liquid crystal device for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;

(e) a wire grid polarization analyzer which removes residual unmodulated first polarization light;

(f) a compensator for conditioning oblique and skew rays from said wire grid pre-polarizer and said wire grid polarization analyzer; and

(g) image-forming optics for forming an image from said modulated beam.

45. The apparatus of claim 44 wherein said compensator comprises one or more birefringent layers, wherein said birefringent layers comprise at least one of the following; an A-plate film, a C-plate film, or a biaxial film.

46. The A-plate according to claim 45 wherein the optical axis of said A-plate is substantially parallel to the sub-wavelength wires of said wire grid polarization beamsplitter.

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47. The A-plate according to claim 45 wherein the optical axis of said A-plate is substantially perpendicular to the sub-wavelength wires of said wire grid polarization beamsplitter.

48. The apparatus of claim 44 wherein said reflective liquid crystal device has a vertically aligned construction.

49. The apparatus of claim 44 wherein said compensator is located between said wire grid pre-polarizer and said wire grid polarization beamsplitter.

50. The apparatus of claim 44 wherein said compensator is located between said wire grid polarization beamsplitter and said wire grid polarization analyzer.

51. A display apparatus comprising:

- (a) a light source for forming a beam of light;
- (b) a pre-polarizer for polarizing said beam of light to provide a polarized beam of light;
- (c) a wire grid polarizing beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;
- (d) a reflective liquid crystal device for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;
- (e) a wire grid polarization analyzer which removes residual unmodulated first polarization light;
- (f) image-forming optics for forming an image from said modulated beam; and

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(g) a compensator, located between said wire grid polarizing beamsplitter and said reflective liquid crystal device for conditioning oblique and skew rays of said modulated beam.

52. A display apparatus comprising:

- (a) a light source for forming a beam of light;
- (b) a pre-polarizer for polarizing said beam of light to provide a polarized beam of light;
- (c) a wire grid polarizing beamsplitter for receiving said polarized beam of light, for transmitting said polarized beam of light having a first polarization, and for reflecting said polarized beam of light having a second polarization;
- (d) a reflective spatial light modulator for selectively modulating said polarized beam of light having a first polarization to encode image data thereon in order to form a modulated beam, and for reflecting said modulated beam back to said wire grid polarizing beamsplitter;
- (e) a compensator, located between said wire grid polarization beamsplitter and said reflective spatial light modulator, for conditioning oblique and skew rays of said modulated beam;
- (f) wherein said wire grid polarizing beamsplitter reflects said compensated modulated beam;
- (g) a polarization analyzer which removes residual unmodulated first polarization light; and
- (h) image-forming optics for forming an image from said modulated beam.

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